Academic Journal of Humanities & Social Sciences

ISSN 2616-5783 Vol. 2, Issue 5: 1-11, DOI: 10.25236/AJHSS.020501

Comparative Research of Critical Thinking Dispositions between Undergraduates of Arts and Science

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ABSTRACT. *This paper adopts California Critical Thinking Inventory as instrument to investigate Chinese university students' critical thinking dispositions as well differences between arts undergraduates and science undergraduates in critical thinking dispositions. The results show that Chinese university students are moderate disposed of critical thinking dispositions; they are especially weak in truth-seeking dimension. Science undergraduates perform slightly better than arts undergraduates in CCTDI, and they are significantly better in inquisitiveness dimension, but there are no significant differences in overall critical thinking dispositions and other dimensions.*

KEYWORDS: *critical thinking dispositions, critical thinking investment, comparative research*

1. Introduction

Critical thinking is "purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation and inference" (The Delphi Report). It is believed that critical thinking plays an indispensable role in human's intellectual development. It has been established as one of the goals of education in many countries. Researchers study critical thinking since 1930s. The research mainly focuses on theoretical framework of critical thinking, assessment of critical thinking and critical thinking practice. Researchers such as Ennis, Robert, Glaser and Facione have done a lot of research in this field. They clarify the definition and structure of critical thinking. Several assessing instruments are also developed.

Research of critical thinking in China started in 1980s. Qualitative research illustrates the connotation and model of critical thinking. Quantitative research includes the verification of the reliability and validity of some Chinese versions of assessing instruments, investigation of English majors' critical thinking, and the relationship of critical thinking between English reading and writing. However, the comparative study of critical thinking among different majors is relatively limited.

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In addition, the present research results on major differences in critical thinking is not consistent. This research makes a comparative study of critical thinking dispositions among arts undergraduates and science undergraduates. The research can provide more empirical data on this topic and also provide some implications for education.

2. Literature Review

This part reviews relevant literature on the definition, dispositions and assessment of critical thinking.

2.1 Definition of critical thinking

Research on critical thinking began in forties of 20th century in America. "Reflective thinking", the pioneering word for critical thinking, was proposed by John Dewey. He viewed it as "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusion to which it tends" (Dewey, 1933). Robert Ennis (1991) defined critical thinking as "reasonable reflective thinking that is focused on deciding what to believe or do". Paul (1993) thought critical thinking involved the ability to ''analyze, criticize, advocate ideas, reason inductively and deductively, and to reach factual or judgmental conclusions based on sound inferences.''

The above definitions focus on different perspectives of critical thinking. In order to promote the research of critical thinking and solve the theoretical dispute on critical thinking, American Philosophic Association (APA) convened 46 experts represented by Peter Facione to discuss the connotations of critical thinking. After a 2-year discussion, a consensus called The Delphi Project was finally achieved. The report proposed a two-dimensional model of critical thinking which contained critical skills and critical dispositions. In the report critical thinking is described as "purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based" (The Delphi Report, American Philosophical Association, 1990). This two-dimensional model is influential and now accepted by more scholars. For the present thesis, the Delphi Report definition is adopted.

2.2 Critical thinking dispositions

The word "disposition" in Cambridge Dictionary means "a natural tendency to do something, or to have or develop something". Literally critical thinking dispositions are thinking tendencies a critical thinker possesses. Facione (1996) put it as attributes that lead a person to have a tendency toward critical thinking. Researchers have put forward types of critical thinking dispositions models. Paul (1993) identified 10 intellectual character traits: intellectual humility, intellectual

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courage, intellectual perseverance, intellectual civility, intellectual integrity, intellectual curiosity, intellectual responsibility, intellectual autonomy, fair-mindedness and faith in reason.

Facione (1996) classified critical thinking dispositions into seven dimensions: truth-seeking, open-mindedness, systematicity, inquisitiveness, analyticity, maturity and self-confidence. Truth-seeking refers to "intellectual honesty, the desire for best knowledge in any situation, the inclination to ask challenging questions and to follow the reasons and evidence wherever they lead". Open-mindedness means "the tolerance for new ideas and divergent views". Analyticity refers to "alertness to potential difficulties and awareness of the need to intervene by the use of reason and evidence to solve problems". Systematicity is "the inclination to be organized, focused, diligent, and persevering". Inquisitiveness is "the intellectual curiosity and the intention to learn things even if their immediate application is not apparent". It refers to curiosity and enthusiasm for knowledge, and attempts to learn and understand, even if the practical value of such knowledge is not directly obvious. Maturity refers to judicious judgment, or no prompt judgment, or modification of existing judgments. Being alert to accept a variety of ways to solve problems. Facione's critical thinking model is extracted from the factor analysis of questionnaire. The model is persuasive and comprehensive. Facione's model is applied in this research.

2.3 Critical thinking assessing instruments

There are about 30 instruments for critical thinking assessing, among them several popular critical thinking assessing instruments are: California Critical Thinking Disposition Invertor (CCTDI) developed by Facione in 1992, California Critical Thinking Skills Test (CCTST) developed by Facione in 1992, Watson-Glaser Critical Thinking Appraisal (WGCTA) developed by Walson and Glaser in 1994, Cornell Critical Thinking Test Level Z (CCTT-Z) developed by Ennis in 2005 (Wang and Wen, 2009). Among these tools, CCTDI is for measuring critical thinking dispositions, others are for measuring critical thinking skills. The assessing instruments mentioned above have been applied by kinds of empirical studies around the world and received good evaluation.

3. Research Design

3.1 Research questions

The following research questions are used to guide the research: 1) what are the critical thinking dispositions of target Chinese university students? 2) Are there any differences between target arts students and science students on overall critical thinking dispositions? 3) Are there any differences between target arts students and science students along the seven subscales that comprise one's critical thinking disposition?

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3.2 Participants

The participants of this research are 285 undergraduates from a key science and engineering university in China. Students with kinds of major backgrounds have chosen the same university-level elective course by the same teacher. Among them, there are 102 students from arts majors and 184 students from science and engineering majors. Most of the participants are freshmen, there are about 50 juniors. The participants age from 16 years old to 23 years old with an average age of 19.23. There are 156 boys and 124 girls. 6 students' information about sex is vacant in the collected questionnaires. The missing information is treated as missing value during data analysis in SPSS.

3.3 Instrument

This paper uses questionnaire as instrument. Among the critical thinking assessment instruments, California Critical Thinking Disposition Invertor (CCTDI) is a questionnaire testing college students' critical thinking dispositions. CCTDI is proposed by Facione and his team in the Delphi Project; it has been applied to many subjects around the world and shows good reliability and validity. It has been translated to different languages. Luo Qingxu and Yang Xinhui (2001) translat it into Chinese and prove its good reliability and validity. This paper adopts the Chinese version of CCTDI to evaluate participants' critical thinking dispositions.

CCTDI is a 75-item questionnaire. Each item is responded on a 6-point Likert scale range from "strongly agree" to "strongly disagree." About 9 to 12 items lead to a common critical thinking dimension stated in Facione's theory. The items from each dimension form the dimension subscale of CCTDI. The seven subscales are truth-seeking, open-mindedness, analyticity, systematicity, inquisitiveness, self-confidence and maturity. Each subscale is independent. Adding the points of seven subscales gets the overall points of critical thinking dispositions. Based on a person's responses to items, the results offer reasonable estimation of a person's overall critical thinking dispositions and subscale dispositions.

The questionnaire are handed out to students in the classroom with the assistance from the teacher of the classmates. All the data are put into SPSS 19.0 for further analysis.

4. Results and Discussion

This part reports the mainly results replying to the three research questions, then makes some discussions about the results.

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4.1 Critical thinking dispositions of the participants

The author firstly tests the reliability of the applied questionnaire. After recoding all the reverse items in CCTDI, item analysis and reliability analysis are operated respectively. Item analysis shows 80% items in CCTDI were significantly different between the first quarter and the last quarter of the groups at the 0.05 level and did not contain 0 within the 95% confidence interval. The Cronbach α value is 0.797. The two results show that the questionnaire used in this research is reliable.

Participants' overall score of critical thinking dispositions and subscale scores of critical thinking disposition in each dimension are calculated according to California Critical Thinking Dispositions Inventory Manual. Then descriptive analysis is operated for the scores. Table 1 presents the situation of overall critical thinking disposition of the participants: mean, minimum, maximum and standard deviation (SD).

Table 1 Overall score of CCTDI for all participants

	N	Mean	Minimum	Maximum	SD
Overall score	286	285.34	168.10	353.30	0.48

Note: N= Number of subjects

According to California Critical Thinking Dispositions Inventory Manual, students with overall scores less than 210 are defined as negatively disposed toward critical thinking dispositions, students with overall scores between 210 and 280 are defined as ambivalently disposed, with overall scores between 280 and 350 are defined as positively disposed, and with overall scores above 350 are defined as strongly disposed. Table 1 shows the mean overall score of critical thinking disposition for these participants is 285.34, with minimum 168.10 and maximum 353.3. So the participants in this science and engineering university are generally positively disposed of critical thinking dispositions. But they just pass the marginal value, their critical thinking dispositions are not strong. In addition, there is a great range between minimum and maximum.

Table 2 Subscale score of CCTDI for all participants

Subscale	N	Mean	Minimum	Maximum	SD
Truth-seeking	286	34.95	22.00	46.00	3.93
Open-mindedness	286	37.87	20.00	51.00	4.21
Analyticity	286	41.32	26.18	54.55	4.44
Systematicity	286	39.45	18.67	56.00	6.64
Inquisitiveness	286	45.72	20.40	57.60	6.06
Self-confidence	286	41.89	12.00	57.33	6.20
Maturity	286	44.15	29.33	57.33	5.36

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Table 2 presents the subscale scores, namely critical thinking disposition in each dimension. California Critical Thinking Dispositions Inventory Manual illustrates that a subscale mean score of 30 and below indicates negative tendency of the given attributes of critical thinking disposition, a subscale mean score less than 40 reflects weak attributes, and a subscale mean score between 40 and 50 shows moderate attributes, a subscale mean score above 50 shows strong tendency of the given characteristic. From table 2 we can see the sequence of target Chinese university students' subscale scores from highest to lowest are: inquisitiveness (M=45.72), maturity(M=44.15), self-confidence (M=41.89), analyticity (M=41.32), systematicity (M=39.45), open-mindedness (M=37.87) and truth-seeking (M=34.95). Four subscale scores are over 40, with inquisitiveness highest followed by maturity, self-confidence and analyticity, which means students are moderate in the four dimensions. Three subscale scores are less than 40: systematic, open-mindedness and truth-seeking, with truth-seeking the lowest. The results suggest that the examined Chinese university students are weak in the three dimensions, especially in truth-seeking.

4.2 Comparison of overall CCTDI between arts and science undergraduates

The overall score of critical thinking dispositions are calculated respectively for arts majors and science majors. Table 3 presents the descriptive results. We can see that both arts students and science students are positively disposed of critical thinking dispositions, but science undergraduates' total score are about 4 points higher than arts undergraduate.

Table 3 Comparison of CCTDI overall score

Group	N	Mean	Minimum	Maximum	SD
Arts undergraduates	102	282.66	222.30	333.10	21.90
Science undergraduates	184	286.82	168.10	353.30	24.34

Table 4 Independent sample test of CCTDI overall score

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Total score	Equal variances assumed	.382	.537	-1.436	284	.152	-4.16744	2.90143	-9.87848	1.54360
	Equal variances not assumed			-1.480	227.735	.140	-4.16744	2.81490	-9.71403	1.37915

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In order to verify whether there are significant differences between the two groups, independent samples test is further operated to test this question. Table 4 shows the results. Table 4 shows the Sig. (2-tailed) value of the independent samples test between the two groups for CCTDI total score is 0.152, higher than criterion measure 0.05; and zero is included in the upper and lower limits of 95% confidence interval. It indicates that although the mean score of science students is higher than arts students, there is no significant difference between the two groups.

Table 5 Level distribution of overall critical thinking dispositions

Group	Low level (score<280)	Middle level (score≥280<350)	High level (score≥350)
Arts	45.09%	54.9%	0%
Science	40.22%	59.24%	5.43%

Table 5 compares level distribution of overall critical thinking dispositions between arts undergraduates and science undergraduates. We can see from the table that 45.09% arts undergraduates are ambivalently disposed of critical thinking dispositions in contrast of 40.22% science undergraduates. 54.9% arts students are positively disposed of critical thinking dispositions, and no arts undergraduate is disposed of strong critical thinking dispositions. For science majors, nearly 60 percent students are in the middle level, and there is data in high level. So science undergraduates perform slightly better in overall score of CCTDI.

4.3 Comparison of CCTDI subscale score between arts and science undergraduates

Table 6 Comparison of subscale score of CCTDI

	Group	N	Mean	Minimum	Maximum	SD
Truth-seeking	Arts	102	34.76	22.00	46.00	3.86
	Science	184	35.05	24.00	44.00	3.97
Open-mindedness	Arts	102	37.68	26.00	46.00	4.05
	Science	184	37.97	20.00	51.00	4.30
Analyticity	Arts	102	41.39	31.64	52.36	3.88
	Science	184	41.28	26.18	54.55	4.73
Systematicity	Arts	102	38.69	21.33	50.67	5.96
	Science	184	39.86	18.67	56.00	6.97
Inquisitiveness	Arts	102	44.72	24.00	57.60	6.01
	Science	184	46.27	20.40	57.60	6.04
Self-confidence	Arts	102	41.45	18.67	57.33	6.77
	Science	184	42.13	12.00	53.33	5.87
Maturity	Arts	102	43.95	30.67	56.00	5.02
	Science	184	44.26	29.33	57.33	5.55

Notes: N= Number of subjects
Arts= arts undergraduates
Science= science undergraduates

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In order to know the differences on the seven dimensions of CCTDI between arts and science undergraduates, the subscale scores for each group are calculated in terms of California Critical Thinking Dispositions Inventory Manual. Table 6 shows the comparison on subscale scores between the two groups on mean, minimum, maximum and SD.

From table 6 we can see science undergraduates score a little higher on the dimension of truth-seeking, open-mindedness, systematicity, inquisitiveness, self-confidence and maturity. Arts undergraduates score higher than science undergraduates only in the dimension of analyticity. Excessing points by science majors are from 0.29 in truth-seeking dimension to 1.55 in inquisitiveness dimension.

In order to verify whether significant differences exist between arts and science undergraduates on subscale scores of CCTDI, independent sample test for each subscale is operated. The result is shown in table 7.

Table 7 Independent sample test of CCTDI subscale score

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TP1T	Equal variances assumed	.508	.476	-.597	284	.551	-.28964	.48555	-1.24538	.66609
	Equal variances not assumed			-.601	213.648	.548	-.28964	.48163	-1.23901	.65972
TP2O	Equal variances assumed	.020	.889	-.541	284	.589	-.28112	.51981	-1.30429	.74206
	Equal variances not assumed			-.550	218.994	.583	-.28112	.51126	-1.28873	.72650
TP3A	Equal variances assumed	3.707	.055	.196	284	.844	.10777	.54854	-.97196	1.18749
	Equal variances not assumed			.208	244.449	.836	.10777	.51848	-.91348	1.12902

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TP4S	Equal variances assumed	2.000	.158	-1.429	284	.154	-1.16951	.81814	-2.77990	.44089
	Equal variances not assumed			-1.494	236.860	.136	-1.16951	.78256	-2.71118	.37216
TP5I	Equal variances assumed	.084	.772	-2.072	284	.039	-1.54233	.74440	-3.00757	-.07709
	Equal variances not assumed			-2.074	209.395	.039	-1.54233	.74348	-3.00798	-.07667
TP6C	Equal variances assumed	1.314	.253	-.887	284	.376	-.67945	.76571	-2.18665	.82774
	Equal variances not assumed			-.852	184.985	.395	-.67945	.79761	-2.25303	.89412
TP7M	Equal variances assumed	1.065	.303	-.473	284	.637	-.31316	.66276	-1.61771	.99140
	Equal variances not assumed			-.486	226.833	.627	-.31316	.64390	-1.58195	.95564

Notes: TP1T= total points of truth-seeking subscale;
TP2O= total points of open-mindedness subscale;
TP3A= total points of analyticity subscale;
TP4S= total points of systematicity subscale;
TP5I= total points of inquisitiveness subscale;
TP6C= total points of self-confidence subscale;
TP7M= total points of maturity subscale;

The Sig. (2-tailed) values for subscales of truth-seeking, open-mindedness, analyticity, systematicity, inquisitiveness, self-confidence and maturity are respectively: 0.56, 0.59, 0.84, 0.15, 0.04, 0.38 and 0.64. Among these figures we can see only the Sig. value for inquisitiveness subscale is lower than criterion measure 0.05 and zero is not included in the upper and lower limits of 95% confidence interval, so significant difference exists on inquisitiveness dimension between arts undergraduates and science undergraduates. For other dimensions, there are no significant difference in statistics.

4.4 Results discussion

The above data reveals several findings. Firstly, the overall mean score of 285.34 indicates undergraduates in this science and engineering university in China

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generally present moderate critical thinking dispositions. Their critical thinking dispositions are not strong by just passing the indicative score 280. For the seven dimensions in critical thinking dispositions, they are disposed of positive critical thinking dispositions only in inquisitiveness, maturity, self-confidence and analyticity dimension. They are especially weak in truth-seeking. The reason may be that most Chinese university students receive exam-oriented education in senior middle school and elementary education. Most of the participants are freshman, their specialties of getting high marks in exams lead them to this top university. However, the pursing of high scores in exams may not bring strong truth-seeking traits. Secondly, science undergraduates score a little higher in the overall critical thinking score than arts undergraduates, but there is no significant differences. The reason may be that major differences cannot lead to critical thinking disposition differences. Both arts major learning and science major learning can develop students' critical thinking in some aspects. Other unmeasured factors such as family background, education system, life experience, knowledge structure, course design, thinking styles etc. affect students' critical thinking dispositions more than major factor. Thirdly, science undergraduates score higher than arts undergraduates in the dimension of inquisitiveness, maturity, self-confidence, systematicity, open-mindedness and truth-seeking; arts undergraduates score higher than science undergraduates in analyticity dimension. But there are no significant differences in these dimensions. Significant differences exist only in the dimension of inquisitiveness. Possible reasons lie in that science majors are trained to discover natural rules, which helps them keep an exploratory heart to the world. The arts major education does not stimulate students' enough inquisitiveness as science major education so far.

5. Conclusion and Implications of the Research

The following conclusions can be drawn from this research: Firstly, Chinese university students are moderate disposed of critical thinking dispositions. Students with strong critical dispositions are very rare. Secondly, Chinese university students present positive critical dispositions in inquisitiveness, maturity, self-confidence and analyticity dimension; they show weak critical thinking dispositions in systematic, open-mindedness and truth-seeking dimension, with highest in inquisitiveness dimension and lowest in truth-seeking dimension. Thirdly, arts undergraduates and science undergraduates are significantly different in inquisitiveness dimension of critical thinking, but not significantly different in overall critical thinking dispositions and maturity, self-confidence, analyticity, systematic, open-mindedness and truth-seeking dimension.

We can get some implications from the research results. Firstly, Chinese university should advance the cultivation methods both in compulsory education and high education to improve students' critical thinking. Secondly, arts major education should be reformed to enhance students' inquisitive characteristics. The course design and evaluation methods are expected to reform in accordance with critical thinking cultivation.

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There are some limitations of this research. Firstly, participants' major distribution are not balanced in this study. There are more science majors than arts majors due to the reason that the participants are from a science and engineering university. This may lead to inaccurate research results. Secondly, participants may not patient enough to finish the long 75-item questionnaire, which may influence the reliability of the study. Thirdly, the samples of the study come from one science and engineering university, which cannot reflect the general situation at all levels and regions. Future researchers could expand types of samples, for example students from a comprehensive university, students from different grades etc. The research of the real factors which affect students' critical thinking is also encouraged to be studied.

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